

Effectiveness of web-based programs on the reduction of childhood obesity in school-aged children: a systematic review

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Executive summary

Background

There has been a rapid rise in obesity among school-aged children despite efforts made in promoting weight management and physical activity. Overweight and obese children are likely to stay obese into adulthood and are more likely to develop diabetes and cardiovascular diseases at a younger age. Using web-based technology is one avenue to reach this population. Web-based technology is fast and interactive which makes it appealing to this population; therefore, it may increase participation and adherence. To date, the evidence has not been systematically evaluated to determine if web-based interventions have a positive impact on reducing childhood obesity.

Objective

To identify the best available evidence on the effectiveness of web-based programs on the reduction of childhood obesity in school-aged children.

Inclusion criteria***Types of participants***

School-age children, four to 18 years of age, regardless of gender, ethnicity, or national origin.

Types of interventions

Web-based programs including, but not limited to, the Internet, social networking media, mobile applications, and email aimed at the reduction of obesity among school-age children.

Types of outcomes

Weight measures such as body mass index, body weight, and/or waist circumference.

Types of studies

Randomized and pseudo-randomized control trials.

Search strategy

To find both published and unpublished studies in the English Language from 1991 through August 2012. A search of MEDLINE, CINAHL, EMBASE, PubMed, PsychINFO, Healthsource Nursing/Academic Edition, ERIC and Academic Search Premier was conducted. A search for gray literature was also performed.

Methodological quality

Two reviewers evaluated the included studies for methodological quality using standardized critical appraisal instruments from the Joanna Briggs Institute.

Data collection and synthesis

Data were extracted using standardized data extraction instruments from the Joanna Briggs Institute. Due to clinical heterogeneity between included studies, statistical meta-analysis was not possible. Results are presented in a narrative form.

Results

A total of 12 articles describing eight interventions were included in this review. All of the included studies were randomized controlled trials. Four of the eight interventions showed improvements in weight measurements. One study demonstrated a reduction in body mass index z-score at 16-weeks post intervention ($F[5,60]=5.11$, $p=0.027$). One study demonstrated a reduction in waist-hip ratio at eight-months post intervention (effect size = -0.01 , $p=0.02$). One study demonstrated a greater loss in mean body fat in the intervention group compared to the control group (-1.12 ± 0.47 vs. 0.42 ± 0.47 , $p<0.05$). One study demonstrated a reduction in body mass index ($t_{87} = -2.7$, $p<0.01$) and body mass index z-score ($T_{87} = -3.1$, $p<0.01$) at nine-months follow-up. Two interventions showed no difference in weight measures post intervention; two interventions showed an increase in body mass index post intervention.

Conclusions

A reduction in overweight and obesity in school-aged children may be seen with the implementation of web-based weight reduction interventions as part of a multi-component intervention. The studies included in this review suggest that other components, such as parental involvement, face-to-face mentoring, and feedback and reminders, when coupled with web-based weight management interventions, may improve patient outcomes.

Implications for practice

The evidence suggests that using web-based technology as part of multicomponent intervention for the implementation of weight reduction programs in school-aged children is promising.

Implications for research

Future studies should evaluate the effects of web-based technology as a single intervention on a larger sample over longer periods of time to establish the full effect of web-based interventions on reducing childhood obesity.

Keywords

pediatric, adolescent, children, obesity, morbid obesity, overweight, weight, body mass index, BMI, waist circumference, waist-hip ratio, weight loss, weight control, web-based, internet, online, blogging, blogs, social media, world wide web, communications media, instructional media, multimedia, social networks, mobile application, email, telecommunications, computer mediated communication, electronic communication

Background

Childhood obesity is one of the most serious public health challenges of the 21st century. The problem is global and is steadily affecting many low- and middle-income countries, particularly in urban settings.¹ The prevalence has increased at an alarming rate globally.² The International Association for the Study of Obesity estimates that up to 200 million school-age children are either overweight or obese, and of these 40-50 million are classified as obese.² Obesity has a negative health impact in childhood, as well as in the long term.²

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health.² Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity. It is defined as a person's weight in kilograms divided by the square of his/her height in meters (kg/m^2).² The World Health Organization defines overweight as BMI greater than or equal to 25 and BMI greater than or equal to 30 as obesity.² Children two years of age or older with a BMI between the 85th and 94th percentile on age-growth charts are considered overweight; children with a BMI greater than the 95th percentile are considered obese.² BMI provides the most useful population-level measure of overweight and obesity as it is the same for both sexes and for all ages worldwide.²

Measures of central obesity such as the waist-hip ratio and waist circumference can provide more robust indices of overall obesity-related health risk than BMI alone.² The waist-hip ratio, when used as a measurement of obesity, is a possible indicator of other more serious health conditions.¹ To determine the waist-hip ratio waist circumference is measured using a measuring tape (in either centimeters or inches) just above the navel and hip circumference is measured at the widest part of the hip. The waist-hip ratio is determined by dividing the waist measure by the hip measure; obesity is defined as a waist-hip ratio greater than 0.90 in males and 0.85 in females.¹

A BMI z-score is a quantitative measure of the deviation of a specific BMI percentile from the mean of that population.² BMI z-scores correspond to established growth chart percentiles. A positive z-score indicates a child is heavier than the mean and a negative z-score indicates a child is lighter than the mean. Thus, a z-score compares the BMI of a given child to the BMI distribution for a population of children of the same age and sex.² Greater than 1 standard deviation above the mean indicates overweight and greater than 2 standard deviations above the mean indicates obesity. BMI z-score are particularly useful to monitor changes in patients with a BMI about the 99 percentile or the 1st percentile.²

The incidence of obesity has more than doubled since 1980. Overweight and obesity now ranks as the fifth leading global risk for mortality.³ Sixty-five percent of the world's population lives in countries where childhood overweight and obesity kills more people than being underweight.⁴ In addition, 44% of the diabetes burden, 23% of the ischemic heart disease burden, and between 7% and 41% of certain cancers burden are attributable to overweight and obesity.⁴

Childhood obesity continues to be a serious health problem in the United States. There has been a rapid rise in obesity among school-age population despite efforts made by Healthy People 2010 in promoting weight management and physical activity.⁵ These on-going efforts have been extended to be part of the goals for Healthy People 2020. The United States Centers for Disease Control and Prevention calculated

that approximately 17% of children between the age of two and 19 years were at or above the 97th percentile for being obese.⁶ These figures are more than three times the anticipated 5% set in the Healthy People 2010 report.⁵

Overweight and obese children are likely to stay obese into adulthood and are more likely to develop non-communicable diseases like diabetes and cardiovascular diseases at a younger age.¹ In addition to a higher risk of obesity and non-communicable diseases later in life, affected children experience adverse outcomes such as breathing difficulties, increased risk of fractures, hypertension, early markers of cardiovascular disease, different forms of cancers, insulin resistance, and psychological effects.⁴ Childhood obesity is associated with a higher chance of obesity, premature death, and disability in adulthood.¹ If a child is overweight before eight years of age, obesity in adulthood is likely to be more severe.⁷

Child and adolescent obesity is also associated with increased risk of emotional problems.⁸ Teens with weight problems tend to have much lower self-esteem and are less popular with their peers.⁷ Depression, anxiety, and obsessive compulsive disorder can also occur as a result of childhood obesity.⁹

In addition to the diseases associated with obesity, the economic consequences of obesity are enormous for families, health care systems, and the global economy. Direct medical costs include preventative, diagnostic, and treatment services related to overweight and associated co-morbidities. European nations spend 2-8% of their health care budgets on obesity, equating to 0.6% of their gross domestic product.¹⁰ In the United States, estimates based on 2008 data indicated that overweight and obesity account for \$147 billion in total medical expenditure.¹¹ This shows an increase from the \$117 billion spent in the year 2000.¹²

While indirect costs of overweight and obesity on society can be considerably higher, they are often overlooked.¹³ These costs stem from childhood obesity continuing on to obesity in adulthood, which can then result in income lost from decreased productivity, reduced opportunities and restricted activity, illness, absenteeism, and premature death.¹ In addition, there are high costs associated with the numerous infrastructure changes that societies must make to cope with obese people such as reinforced beds, operating tables and wheel chairs; enlarged turnstiles and seats in public gathering spaces; and modifications to transportation safety standards.¹

Obesity is reaching pandemic proportions across much of the world, and its consequences are set to impose unparalleled health, financial, and social burdens on global society unless effective actions are taken to reverse the trend. Reducing the incidence of obesity in childhood can help children grow into adults with normal body weights and the tools necessary to sustain a health weight.

Hearens et al.¹⁴ explains the importance of school-based programs in dealing with the serious problem of childhood obesity and overweight. The school setting has a powerful influence on students' eating and physical activities.¹⁴ Programs that may have a more positive impact are those that help increase physical activity and promote healthy foods in youth. Previous studies looking at the implementation of diet and exercise programs in schools were effective in changing eating habits and increasing physical activity; however, few of these studies showed a reduction in body weight. The *Planet Health* study,¹⁵ conducted over a period of two years, focused on healthy lifestyles and showed a reduction in obesity in girls but not

in boys. The *M-span* study,¹⁶ a two-year study involving proper diet, exercise, and parental support, showed a reduction of BMI only in boys. Hearens et al.¹⁴ further explains that the above mentioned studies needed to be done in a more personalized manner in order to achieve more positive results; however, they are limited by the time consumption and financial demands necessary to carry out the proposed intervention.

A two-year study¹⁴ was conducted on the effects of a program including physical activity, healthy eating, and parental support with a computer-tailored component on BMI and BMI z-scores in boys and girls. This intervention resulted in a reduction in BMI in girls only. A 12-month web-based weight loss intervention program which included physical activity and dietary behavior was found to be a potential low-cost method to positively impact public health and health behaviors.¹⁷ Furthermore, 55% of the participants in the intervention group compared with 35% in the control group made an improvement in moderate-to-vigorous physical activity and diet.¹⁷

The United States Department of Health and Human Services report of 2009 indicates that school-age children spend an average of seven hours and 11 minutes per day watching television, using a computer, and playing video games.¹³ Using these technological devices as educational tools could have a noteworthy impact by increasing knowledge about healthy choices.¹⁸ Web-based technology has become part of our children's lives in the last decade providing the foundation for a large number of daily activities.¹⁵ The use of web-based technology may be one method to provide a more personalized intervention to reduce obesity in school-age children.¹⁸

Web-based programs to help in the reduction of obesity typically provide education on healthy eating and physical activities, in addition to, utilizing peer support in an on-line forum. Users are able to record their progress while working to achieve weight loss goals. However, the benefits derived from these programs may be related to the frequency and accuracy by which the users record their adherence to recommended diet, activity, and weight monitoring.

The search for previously conducted systematic reviews on the effectiveness of web-based programs on obesity in children identified a systematic review⁷ that included studies published between 1995 and April 2009. A critical appraisal of this systematic review determined it to be of reduced quality due to lack of transparency in reporting the details of the search strategy, the inclusion and exclusion criteria, and the assessment of the primary studies' methodological quality. This systematic review expanded on the prior systematic review using the rigorous search strategy and assessment for methodological quality outlined below to identify the best available research to determine the effectiveness of web-based programs on childhood obesity. The current review also sought to identify more current research on the topic while expanding the inclusion criteria from the web-based interventions included in the prior systematic review⁷ to other forms of web-based technologies, such as smart phones, that have become increasingly popular with this population.

Review Objective

The objective of this review is to synthesize the best available evidence on the effectiveness of web-based programs on the reduction of childhood obesity in school-age children.

Inclusion criteria

Types of participants

This review considered studies that include school-age children regardless of gender, ethnicity, or national origin from four to 18 years of age.

Types of interventions

This review considered the use of web-based programs alone or as one component of a multi-component intervention. Web-based programs may include, but are not limited to, the Internet, social networking media, Internet mobile applications, and email aimed at the reduction of obesity among school-age children.

Types of outcomes measures

The outcomes considered in this review included measures of overweight and obesity among school-age children as measured by valid and reliable measurements including but not limited to BMI, body weight, and/or waist circumference.

Types of studies

This review considered randomized controlled trials (RCTs) and pseudo-randomized control trials.

Search strategy

Both published and unpublished research studies available in the English language from 1991 through August 2012 were sought. The authors of this systematic review utilized a comprehensive three-step search strategy. An initial limited search of PubMed and CINAHL was undertaken followed by an analysis of the text words contained in the title and abstract, and of the index terms used to describe an article. A second search using all identified keywords and index terms was undertaken across all included databases (see Appendix I for the detailed search strategies of the included databases). Thirdly, the reference list of all identified reports and articles was searched for additional studies. Studies identified from reference list searches were assessed for relevance based on the study title.

The use of the web for communication purposes came into existence in 1991, but it was not really until the mid to late 1990s that information professionals understood its usefulness and the magnitude of a

medium that would have far-reaching positive consequences.¹⁹ This systematic review included studies published from 1991 to August 2012 to identify all relevant studies on this topic.

The databases searched included: Excerpta Medica Database (EMBASE), Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, Health Source: Nursing/Academic Edition, Education Resources Information Center (ERIC), Academic Search Premier, and PsycINFO.

The search for unpublished studies included: Virginia Henderson International Nursing Library, The New York Academy of Medicine, ProQuest Dissertation & Thesis (formerly known as Dissertation Abstracts Online), MedNar, Scirus, and the World Health Organization Institutional Repository.

Initial keywords used were: obesity, overweight, children, pediatric, technology, web based, and body mass index.

The full list of keywords used was: pediatric, pediatrics, adolescent, adolescence, child, children, obesity, morbid obesity, overweight, weight, body weight, body mass index, BMI, waist circumference, waist-hip ratio, weight loss, weight control, web-based, internet, online, blogging, blogs, social media, world wide web, communications media, instructional media, multimedia, social networks, social networking, mobile application, email, electronic mail, online social network, telecommunications, computer-mediated communication, electronic communication, reduce, decrease, and decline.

Methods of the review

Assessment of methodological quality

Quantitative papers selected for retrieval were assessed by two independent reviewers for methodological quality prior to inclusion in the review. The reviewers used the standardized critical appraisal instruments from the Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument (JBI-MASARI) (Appendix II). The randomized controlled and pseudo-randomized controlled trials chosen were to have met a minimum of six out of 10 questions from the standardized critical appraisal instrument from JBI-MASARI, with questions 6, 7, 8, and 9 being the most important to be answered in the affirmative in order to be considered of adequate quality for inclusion in the review. Any disagreement that arose between the reviewers was resolved through discussion, or with a third reviewer.

Data extraction

Data from quantitative studies was extracted by two independent reviewers using the standardized data extraction tool from JBI-MAStARI (Appendix III). The data extracted included specific details about the interventions, populations, study methods, and outcomes of significance to the review question and specific objectives. Any disagreement that arose between the reviewers was resolved through discussion or with a third reviewer.

Data synthesis

Due to the clinical and methodological heterogeneity of the included studies' participants, interventions, and outcome measures, statistical pooling via meta-analysis was not possible. The results are presented in narrative form.

Review results

A total of 4058 citations were identified by the comprehensive search of the literature. After a review of the titles and keywords 4019 citations were excluded. Thirty-nine full text papers were retrieved for further review as additional information beyond the abstracts was needed to determine if the paper met the inclusion criteria for this review. After reviewing the full text articles, 27 were excluded for not meeting the inclusion criteria. Twelve articles were appraised for methodological quality and all 12 were included in the review. Figure 1 outlines the stages of identification and retrieval of studies for inclusion. See Appendix IV for the list of the full text studies reviewed and the reasons for exclusion.

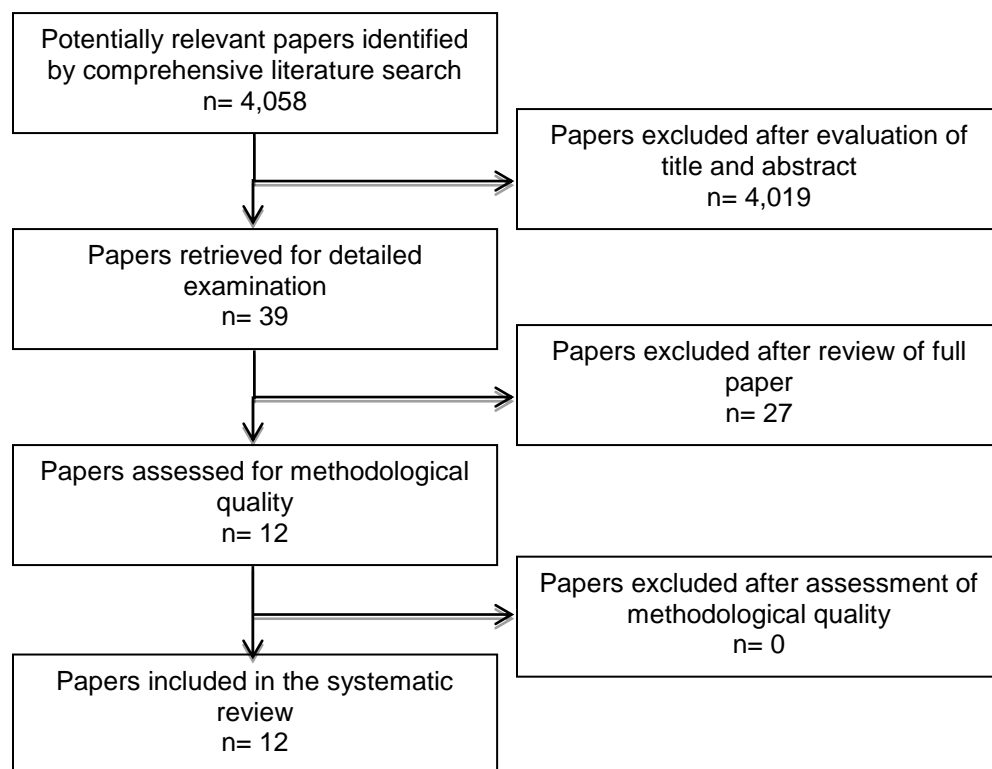


Figure 1: Flowchart of the stages of identification and retrieval of studies for inclusion

A total of 12 articles describing eight interventions were included in this review. All of the included studies were RCTs. Details of included studies may be found in Appendix V.

The sample size of the included studies ranged from 30 to 883. Six of the included studies had samples of heterogeneous adolescents.^{20,22-26} One study included only boys, aged 10-14 years,²⁷ one study included only eight-year old girls,²¹ and one intervention written up in four papers included only girls, aged 11-15 years.²⁸⁻³¹ Three interventions included a population of a single ethnicity (Chen et al.,²⁵ Chinese Adolescence; Baranowski et al.,²¹ African American girls; and the White et al. and Williamson et al. papers,²⁸⁻³¹ African American girls). The length of the included interventions ranged from five to 52 weeks. The interventions included in this review utilized web-based programs targeting weight loss, body image improvement, and behavior modification for weight control.

Methodological quality

A total of 12 articles describing eight interventions were included in this review. They were all determined to be of adequate quality after assessment using the JBI-MAStARI critical appraisal tool. All the included studies were RCTs. Ten of the 12 included articles met the minimum of six out of 10 questions answered 'yes' from the standardized critical appraisal instrument from JBI-MAStARI, with questions 6, 7, 8, and 9 being the most important that had to be answered 'yes'. Two articles, while meeting the 6/10 criteria, had a 'no' for question 6. In Ezendam et al.,²⁰ there was some difference in the intervention and control group at baseline, specifically in the type of school attended and western versus non-western background of the participants. Other characteristics were not statistically different between the two groups. In Baranowski et al.²¹ there were differences between mean BMI in the control and intervention groups at baseline. The authors of these two studies^{20,21} used randomization to create the group and the differences were a result of the randomization process; therefore, the reviewers agreed to include these studies in the review even though question 6 on the appraisal tool had a 'no' answer. See Table 1 for details of the assessment for methodological quality.

Characteristics of included studies

In Baranowski et al.,²¹ a RCT, 35 African American girls, aged eight, from a summer day camp in Houston, Texas, USA, along with their parents/caregivers, were evaluated in two parallel groups. The intervention group received a four-week summer camp program with camp activities to promote healthy eating and physical activity. After the summer camp, the participants and their parents/caregivers received an additional eight-week web-based intervention at home aimed at promoting healthy eating habits and physical activity. The website included goal setting activities. The adolescents received weekly emails or telephone reminders to participate. The parental website promoted desired parenting behaviors and allowed parents to set goals for lifestyle changes for their daughters. The control group had a four-week summer camp that included usual camp activities followed by access to a website with general health information. Limitations of this study included the small sample size, the low adherence rates, and baseline differences in the mean BMI between groups at baseline (Intervention group 21.1, control group 26.3, $p < 0.01$).

Table 1: Methodological quality**Number of studies included and excluded**

Number of studies included	Number of studies excluded
12	0

Randomized control trial/pseudo-randomized trial

Citation	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Baranowski et al., 2003 ²¹	Y	U	Y	Y	U	N	Y	Y	Y	Y
Celio, 2005 ²²	Y	U	U	Y	Y	Y	Y	Y	Y	Y
Celio Doyle et al., 2008 ²³	Y	U	U	Y	Y	Y	Y	Y	Y	Y
Chen et al., 2011 ²⁵	Y	U	Y	N	U	Y	Y	Y	Y	Y
Ezendam et al., 2012 ²⁰	Y	Y	U	Y	U	N	Y	Y	Y	Y
Jago et al., 2006 ²⁷	Y	U	U	Y	U	Y	Y	Y	Y	Y
Jones et al., 2008 ²⁴	Y	U	Y	Y	N	Y	Y	Y	Y	Y
Moore & O'Donohue, 2011 ²⁶	Y	U	U	N	U	Y	Y	Y	Y	Y
White, 2003 ²⁸	Y	U	U	Y	N	Y	Y	Y	Y	Y
White et al., 2004 ²⁹	Y	U	U	Y	N	Y	Y	Y	Y	Y
Williamson et al., 2005 ³⁰	Y	U	U	Y	N	Y	Y	Y	Y	Y
Williamson et al., 2006 ³¹	Y	U	U	Y	N	Y	Y	Y	Y	Y
%	83.33	8.33	25.00	83.33	16.67	83.33	100	100	100	100

Celio²² completed a dissertation in 2005 describing an RCT of 63 ethnically-diverse overweight or at-risk for overweight (BMI \geq 85th percentile) adolescent boys and girls, aged 12-18 years from San Diego, California, USA, and St. Louis, Missouri, USA. Participants were randomized to participate in a 16-week web-based program aimed at weight loss and improvement in body image. In a subsequent article by Celio Doyle, et al.,²³ the sample was extended to include a total of 80 adolescents. The intervention used a cognitive-behavioral approach to provide weekly content on health education, guided behavior modification for weight control, and cognitive exercises for improving body image. Participants recorded food intake, physical activity and weekly weights in an online journal. Participants were expected to spend one to two hours per week, but no more than 30 minutes a day using the program. Weekly emails were sent to participants with individualized feedback. The website provided an online, moderated, asynchronous discussion group. Parents also received monthly newsletters to encourage them to create

a positive and constructive home environment for the adolescents to achieve their goals. The control group adolescents and parents received a colored handout with basic health information and physician follow-ups as needed. The control group was informed they would receive access to the web-based program at the completion of the study. Limitations to this study included the small sample size and the lack of long term follow-up.

In Chen et al.,²⁵ a RCT, a total of 54 Chinese American adolescent girls and boys, aged 12-15 years, from San Francisco, California, USA, were randomized to participate in a study to examine the efficacy of the “web ABC” program for promoting healthy lifestyles and healthy weight. The web-based program consisted of activities in eight weekly online sessions each lasting 15 minutes to enhance the self-efficacy of adolescents and facilitate their understanding and use of problem-solving skills related to nutrition, physical activity and coping. Participants completed an online diary to monitor diet and physical activity, and received individually-tailored feedback based on the behavioral stage of the adolescent. Adolescents also used an interactive dietary preparation software program (“The Wok”) featuring common Chinese foods. Parents of the adolescents in the intervention group received three sessions, each lasting 15 minutes, aimed at creating a healthy family environment. The control group received general health information related to nutrition and healthy lifestyle choices via the web during eight weekly sessions lasting 15 minutes each. Information was adapted from the American Academy of Pediatrics, the Centers for Disease Control and Prevention and the American Heart Association, and was not individually tailored. Limitations of the study include convenience sampling, small sample size, use of single ethnic population limiting the generalizability of the results, use of self-report measures, and a short follow-up time.

In Ezendam et al.,²⁰ a RCT using cluster randomization, 883 adolescent boys and girls, aged 12-13 years, were recruited from 20 schools in the Netherlands. Schools were randomized to either the intervention or control arm of this study. The intervention consisted of a web-based intervention consisting of eight modules addressing issues of weight management and energy balance-related behaviors. Education included increasing physical activity, reducing sedentary lifestyles, increasing intake of fruits, vegetables and whole wheat breads, and reducing intake of sugar beverages. Individual feedback was provided on behavior and cognitive modification, and barrier identification. Teachers allocated 15 minutes for each module over a period of 10 weeks. The control group received a regular curriculum which was not detailed by the authors. Limitations to this study included self-reported measures, high attrition, and group differences at baseline, specifically in the type of school attended and western versus non-western ethnicity.

In Jago et al.,²⁷ a RCT using cluster randomization, 473 Boy Scouts, aged 10 to 14 years from Houston, Texas, USA, were recruited from 42 Boy Scout troops. The Boy Scout troops were randomized to either the intervention or control arm of this study. The intervention group received the “Fit for Life” physical activity program, a nine-week program that included skill building activities at troop meetings along with a web-based role modeling, goal setting and problem-solving program. Participants received 20-minute

physical activity sessions during the troop meeting and were encouraged to continue activities outside of the meeting. Participants also logged into the study website twice per week to complete animated role-modeling activities and set goals. The control group received a similar nine-week program that included a fruit and vegetable intervention in place of the physical activity intervention. Limitations to this study included the small sample of single gender participants who were predominantly Anglo-American and middle class. There were seasonal effects that showed improvement in outdoor physical activity in the spring cohort compared to the fall cohort.

In Jones et al.,²⁴ a RCT, 105 adolescent boys and girls, mean age 15.1 years, at risk for obesity (BMI \geq 85th percentile) were randomized to participate in a 16-week web-based intervention. Participants were from two public high schools in Boise, Idaho, USA, and Hayward, California, USA. The program combined psycho-education and behavioral interventions including self-monitoring, goal setting, and awareness of appetite triggers. The online interactive program involved journals for a diet log, weight, physical activity, and personal thoughts and goals. There were also asynchronous discussion groups moderated by a research assistant. Weekly letters were sent out to reinforce participation and motivational messages were mailed as well. To increase adherence, parents were provided with handbooks. Due to low adherence in the first cohort, participants in cohort 2 were given the option of meeting face-to-face with a mentor. However, these participants only attended one mentoring session. The control group received a regular curriculum which was not detailed by the authors. The control group was informed they would receive access to the web-based program at the completion of the study. Limitations to this study included the small sample size, the use of self-reported measures, and the lack of correlation between adherence and outcome. It was noted that most participants used the online program for less than eight-weeks, yet they were able to reduce their weight and BMI.

Moore and O'Donohue,²⁶ a RCT, explored the feasibility of a web-based application of a family-based behavioral treatment program. Thirty at-risk or overweight children, aged 6-12 years, from small rural towns in California and Nevada, USA, were randomized to participate in this study. The intervention group received a web-based psycho-education program consisting of five family-based interactive modules addressing behavior modification and self-monitoring, nutrition, physical activity, child management skills training, and relapse prevention. Families were also provided with monitoring logs, journals, recipes, and self-help resources. The control group received usual care, which was not detailed by the study authors. The control group was offered access to the intervention at the conclusion of the study. Limitations to this study included the small sample size, high attrition rate, and the short follow-up period.

The results of a 24-month RCT evaluating 57 African American adolescent girls, aged 11-15 years, from Louisiana, USA, with at least one obese parent were published in four separate articles. The first publication was a dissertation by White²⁸ that was followed by a subsequent article by White, et al.²⁹ detailing the six-month post-intervention outcomes. Williamson, White, and colleagues³⁰ then went on to

reanalyze the six-month outcome data and published their results in a third article. Finally, the results of the outcome data 24-months post-intervention was published in a fourth article by Williamson, et al.³¹

Participants in this study were randomized to receive an interactive web-based lifestyle behavior modification program for weight management or a control intervention. The web-based behavioral program utilized by both the adolescent and the parent consisted of 52 lesson plans to be completed over the first year of this two-year program. Lessons included nutritional education and a behavior modification program that targeted lifestyle, physical activity, and eating habits, including recipes for food commonly eaten by African Americans. Participants also attended four face-to-face counseling sessions and were encouraged to adhere to the behavioral principles. Further counseling for behavior modification was accomplished by asynchronous email communication. Along with providing email access, the website contained a variety of interactive components for self-monitoring weight, diet, and physical activity. The control group received health education during face-to-face sessions and links to non-interactive websites promoting a healthy lifestyle without prescribing behavior changes. Limitations of the study included the small sample size and the use of a homogenous sample of African American girls, which limits the generalizability of the results.

Results

The Baranowski et al.²¹ study did not show any differences in BMI or waist circumference between the two groups at the end of the 12-week summer day camp and web-based program (Table 2). In a secondary analysis, when the sample was restricted to girls with a baseline BMI greater than 22.1, there was a trend toward a lower BMI for the treatment group (BMI 28.6) compared to the control group (BMI 29.3) post intervention. Table 2 outlines the post intervention mean (standard deviation [SD]) BMI and waist circumference and differences adjusted for baseline values.

The Celio²² and Celio Doyle et al.²³ intervention demonstrated a statistically significant reduction in BMI z-scores in the intervention group compared to the control group at the end of the 16-week intervention ($F[5,60] = 5.11, p = 0.027$); however, this reduction was not sustained at the four-months post intervention follow-up visit ($F[5,60] = 1.14, p = 0.289$) due to parallel improvements in both the intervention and control groups. The absolute reduction in BMI z-score from baseline was greater for the intervention group compared to the control group. Table 3 outlines the mean (SD) BMI, BMI z-score and weight for the intervention and control groups at baseline, post-intervention, and at the four-months follow-up.

Table 2: Post-intervention mean (SD) BMI and waist circumference and differences adjusted for baseline values of a four-week summer camp and subsequent eight-week web-based weight loss intervention

	Intervention, n=17	Control, n=14	Adjusted Differences (SE)	
BMI Mean (SD)	24.6 (1.0)	24.1 (1.1)	0.6 (1.6)	p=0.72
Waist circumference Mean (SD)	74.1 (0.9)	71.7 (1.0)	2.4 (1.4)	p=0.10

BMI= body mass index, SD=standard deviation, SE=standard error.

Note: Results of ANCOVA not reported by study author, p values presented in isolation.

Data from: Baranowski, et al., 2003²³

Table 3: Mean (SD) BMI, BMI z-score, and weight at baseline, post-intervention, and four-months follow-up of a 16-week web-based weight loss intervention

	Intervention, n=33			Control, n=33		
	Baseline	Post intervention	Four-months follow-up	Baseline	Post Intervention	Four-months follow-up
BMI Mean(SD)	34.64 (7.79)	33.99 (7.60)	34.37 (7.64)	33.86 (6.87)	34.07 (6.57)	34.34 (6.90)
BMI z-score Mean(SD)	2.19 (0.50)	2.11 (0.51)	2.10 (0.51)	2.19 (0.44)	2.20 (0.43)	2.15 (0.48)
Weight Mean(SD)	214.50 (65.32)	214.36 (64.23)	218.56 (64.43)	206.06 (50.19)	210.77 (47.21)	214.49 (47.51)

BMI= body mass index, SD=standard deviation.

Data from: Celio Doyle, et al., 2008²³

Chen et al.²⁵ demonstrated that more adolescents in the intervention group than the control group had statistically significant decrease in their waist-hip ratio at eight-months follow-up (effect size = -0.01, p=0.02). No reduction in BMI was noted in either group. Table 4 outlines the mean (SD) BMI and waist-hip ratios at baseline, post-intervention, and eight-months follow-up.

Ezendam et al.²⁰ demonstrated an increase in both BMI and waist circumferences at two-years follow-up (Table 5). Regression analysis at the two-years follow-up showed no effects of the intervention on BMI ($\beta=0.14$, 95% confidence interval -0.17, 0.45) or waist circumference ($\beta=0.12$, 95% confidence interval -0.44, 1.64). Measurements for BMI and waist circumference were not collected at the conclusion of the intervention, so it is unknown if the intervention had any immediate impact on weight loss that was not sustained though the two-years follow-up. Table 5 outlines the mean (SD) BMI and waist circumference at baseline and two-years follow-up.

Table 4: Mean (SD) BMI and waist-hip ratios at baseline, post-intervention, and eight-months follow-up of the “web ABC” weight loss intervention

	Intervention, n=27			Control, n=27		
	Baseline	Post Intervention	Eight-months follow-up	Baseline	Post Intervention	Eight-months follow-up
BMI Mean(SD)	20.79 (3.12)	Not measured	20.76 (3.08)	20.25 (3.21)	Not measured	20.21 (3.13)
Waist-hip ratio Mean(SD)	0.91 (0.04)	0.90 (0.04)	0.88 (0.04)	0.89 (0.04)	0.89 (0.04)	0.89 (0.04)

BMI= body mass index, SD=standard deviation.

Data from: Chen, et al., 2011²⁵

Table 5: Mean (SD) BMI and waist circumference at baseline and two-years follow-up of a 10-week web-based weight loss intervention

	Intervention		Control	
	Baseline	Two-years follow-up	Baseline	Two-years follow-up
BMI Mean (SD)	19.48(3.45) (n=440)	21.08(3.93) (n=391)	19.23(2.96) (n=376)	20.67(3.15) (n=337)
Waist circumference Mean (SD)	67.88(8.13) (n=442)	74.70(9.78) (n=393)	66.82(6.95) (n=376)	73.24(8.20) (n=339)

BMI= body mass index, SD=standard deviation

Data from: Ezendam, et al., 2012²⁰

Jago et al.²⁷ demonstrated an increase in BMI and BMI percentile at the six-months follow-up in both the intervention and control groups. Tables 6 and 7 outline the mean (SD) BMI and BMI percentile for the intervention and control groups at baseline, post-intervention and six-months follow-up for the spring and fall cohorts, respectively.

Jones et al.²⁴ demonstrated a statistically significant decrease in BMI ($t_{87} = -2.7$, $p < 0.01$, effect size 0.6) and BMI z-score ($t_{87} = -3.1$, $p < 0.01$, effect size 0.8) from baseline to the follow-up in the intervention group compared to the control group. The intervention group experienced a greater reduction in overall BMI and BMI-z scores from baseline to follow-up. Table 8 outlines the mean (standard error [SE]) BMI and BMI z-score at baseline, post-intervention, and nine-months follow-up.

The Moore and O'Donohue²⁶ intervention revealed that BMI z-scores remained stable from baseline to post intervention for children in both groups and the children remained classified as moderately obese

throughout their participation in the intervention. Table 9 outlines the mean (SD) BMI z-score at baseline and post intervention.

Table 6: Mean (SE) BMI and BMI percentile at baseline, post-intervention, and six-months follow-up for the spring cohort of the “Fit for Life” weight loss intervention

Spring cohort	Intervention			Control		
	Baseline	Post Intervention	Six-months follow-up	Baseline	Post intervention	Six-months follow-up
Sample size	n=86	n=87	n=76	n=64	n=63	n=64
BMI Mean(SE)	21.3(0.5)	21.3(0.5)	21.7(0.5)	21.3(0.6)	21.2(0.6)	21.7(0.6)
BMI percentile(SE)	64.7(3.0)	64.7(3.0)	67.8(3.0)	63.6(3.6)	63.7(3.6)	67.0(3.6)

BMI= body mass index, SD=standard error

Note: BMI and BMI percentile were significantly greater at the six-months follow-up ($P<0.001$) compared to baseline regardless of intervention or control group (statistical test used not reported by the author).

Data from: Jago, et al., 2006²⁷

Table 7: Mean (SE) BMI and BMI percentile at baseline, post intervention, and six-months follow-up for the fall cohort of the “Fit for Life” weight loss intervention

Fall cohort	Intervention			Control		
	Baseline	Post intervention	Six-months follow-up	Baseline	Post intervention	Six-months follow-up
Sample size	n=141	n=139	n=131	n=160	n=163	n=145
BMI Mean(SE)	21.0(0.4)	21.0(0.4)	21.4(0.4)	21.3(0.4)	21.3(0.4)	21.7(0.4)
BMI percentile(SE)	67.5(2.3)	67.5(2.3)	70.5(2.3)	64.5(2.2)	64.6(2.2)	69.3(2.3)

BMI= body mass index, SD=standard error

Note: BMI and BMI percentile were significantly greater at the six-months follow-up ($P<0.001$) compared to baseline regardless of intervention or control group (statistical test used not reported by the author).

Data from: Jago, et al., 2006²⁷

The six-month outcomes of a 24-month web-based intervention were reported in three articles (White,²⁸ White et al.,²⁹ and Williamson et al.³⁰) and the 24-month outcomes for the same sample were reported in a separate article by Williamson et al.³¹ The results, as reported in Williamson et al.,³⁰ indicate that in the first six months adolescents in the intervention group, when compared to the control group, had a decrease in mean body fat and BMI (Table 10). Looking at BMI percentile, the groups approached a statistically significant difference at six-months ($t_{53} = 1.94$, $p = 0.057$).³⁰ Over the next 18 months of the study adolescents gained weight.³¹ After the 24-months follow-up, statistically significant changes were observed in weight ($F[3,54] = 6.55$, $p<0.001$), BMI percentile ($F[3.54] = 4.14$, $p<0.02$), and BMI ($F[3,54] = 3.13$, $P<0.04$).³¹ Table 10 outlines the change from baseline mean (SE) BMI, BMI percentile, body fat percentage, and weight at six-months and 24-months follow-ups.

Table 8: Mean (SD) BMI and BMI z-score at baseline, post-intervention, and nine-months follow-up of a 16-week web-based weight loss intervention

	Intervention, n=44			Control, n=43		
	Baseline	Post intervention	Nine-months follow-up	Baseline	Post intervention	Nine-months follow-up
BMI	30.58	28.76	29.76	30.6	29.99	31.17
Mean (SD)	(4.9)	(4.72)	(5.34)	(5.97)	(5.92)	(6.33)*
BMI z-score	1.81	1.56	1.60	1.79	1.68	1.76
Mean (SD)	(0.47)	(0.59)	(0.62)	(0.51)	(0.54)	(0.57) †

BMI= body mass index, SD=standard deviation.

*p<0.001 for the intervention group compared with control group (statistical test used not reported by authors).

†p<0.05 for the intervention group compared with the control group (statistical test used not reported by authors).

Data from: Jones, et al., 2008²⁴

Table 9: Mean (SD) BMI z-score at baseline and post-intervention of a web-based weight loss intervention*

	Intervention, n=15		Control, n=15	
	Baseline	Post intervention	Baseline	Post intervention
BMI z-score	2.35 (0.33)	2.35 (0.33)	2.35 (0.33)	2.35 (0.33)
Mean (SD)				

BMI= body mass index, SD=standard deviation.

*p value not reported by authors.

Data from: Moore and O'Donohue, 2011²⁶

Discussion

Obesity is a global problem and its sequelae are damaging to our adolescents. The findings of this review suggest that web-based interventions could have a positive impact on reducing BMI, BMI z-scores, and weight. Four^{22,24,25,30} out of the eight interventions identified in this review have shown a reduction in BMI, BMI-z, weight, waist-hip ratio, and/or body fat. One²¹ interventions showed no difference in BMI post intervention; however, a subgroup analysis including only adolescents with a BMI greater than 22.1 showed a trend toward lower BMIs for the intervention group. Another intervention²⁶ showed BMI z-scores did not change from baseline post intervention. Two interventions^{20,27} had an increase in BMI at follow-up. One study²⁰ only remeasured BMI at 24-months post intervention. The short duration of this intervention (eight sessions of 15 minutes each) was unlikely to demonstrate sustained results to the two-years follow-up assessment, but an improvement in healthy eating behaviours was demonstrated. The other study²⁷ failed to show an improvement in BMI at six-months post intervention but did demonstrate an increase in physical activity among the adolescents.

Table 10: Change from baseline mean (SE) BMI, BMI percentile, body fat and body weight at six months and 24-months follow-ups of a web-based weight management intervention

	Intervention, n=28		Control, n=29	
	Six-months follow-up‡	24-months follow-up§	Six-months follow-up‡	24-months follow-up§
BMI Mean (SE)	-0.19 (0.24)*	0.73(0.66)	0.65 (0.23)*†	1.2 (0.65)
BMI percentile	NA	-0.004 (0.003)	NA	-0.001 (0.003)
Body fat Mean (SE)	-1.12(0.47)*†	-0.08(0.71)	0.43(0.47)*	0.84(0.72)
Body weight (kg) Mean (SE)	0.70 (0.59)	4.4 (1.7)	2.29 (0.56)	6.3 (1.6)

BMI= body mass index, kg=kilogram, NA=not available, SE=standard error

*Indicates statistically significant differences between intervention and control group means ($p < 0.05$ [statistical test not reported by authors]).

†Indicates change from baseline values differ significantly ($p < 0.05$ [statistical test not reported by authors]).

Note: p-values not reported by authors for 24-month outcome data.

‡Data from: Williamson, et al., 2005³⁰ §Data from: Williamson, et al., 2006³¹

Multiple variables have been identified that may have led to interventions achieving positive outcomes. All of the interventions that demonstrated improvements or no change from baseline in weight measures^{21,23-26,31} had parental involvement as part of the intervention. For example, in the Celio Doyle et al.²³ intervention, parents received a monthly newsletter to encourage the creation of a positive home environment in order for adolescents to achieve their goals. Baranowski et al.²¹ included a parental website that modelled desired parenting behaviours and allowed parents to set goals to help their children achieve positive outcomes. In addition, parents received reminders to have their children log on to the website weekly. In the White et al. and Williamson et al.,²⁸⁻³¹ and Moore and O'Donohue²⁶ interventions, parents participated side-by-side with their adolescents in the web-based interventions. Parental education may aid parents in creating a positive environment and reinforces behavioral changes in the adolescents.

Reinforcement of information via reminders such as emails or letters, or the provision of individualized feedback may help to achieve positive outcomes.^{21-24,28-31} In Baranowski et al.²¹ participants received weekly emails or telephone reminders to participate. Weekly letters with motivational messages were sent to participants in the Jones et al.²⁴ study. Participants in Celio Doyle et al.²³ received weekly emails with individualized feedback in addition to the parents receiving monthly newsletters.²³ In White et al. and Williamson et al.²⁸⁻³¹ participants received individualized counselling via email.

Face-to-face interaction may also help to increase adherence. In the White et al. and Williamson et al.²⁸⁻³¹ intervention, participants attended four face-to-face counselling sessions to reinforce adherence to behavior principles. Jones et al.²⁴ offered optional face-to-face mentoring sessions.

Another aspect that was noted to have a positive outcome in the studies was addressing the individual cultural differences of the participants. The Chen et al.²⁵ intervention provided an individually tailored web-based behavior program for Chinese American adolescents, and the White et al. and Williamson et al.²⁸⁻³¹ intervention provided individually tailored web-based behavior program for African American adolescents. These studies used interactive dietary preparation software programs tailored to common cultural food practices of the study participants. According to Chen et al.,²⁵ culturally appropriate programs have greater success at promoting healthy lifestyles and decreasing obesity.

While short term results of web-based interventions to reduce childhood obesity look promising, long term outcomes have not been sustained. Celio Doyle²³ demonstrated a statistically significant reduction in BMI z-scores at the completion of this 16-week intervention but these results were not sustained at the four-months follow-up visit due to parallel improvements in both groups. Participants in the intervention group however, did show a greater reduction in BMI z-score than the control group. Williamson et al.³⁰ demonstrated a statistically significant decrease in BMI and weight at the short term six-months follow-up. At the conclusion of this 24-month intervention,³¹ weight and body fat loss was not maintained possibly due to the high attrition rate and decreased use of the website after one year despite parental involvement, face-to-face counseling sessions, and email communication with a counselor.

Limitations of the review

This systematic review has some limitations. This review only sought articles published in the English language. It is unknown if there are other studies focusing on web-based technologies to decrease obesity that were published in other languages.

The majority of the studies included in this review had small sample sizes, which limit the reliability of the results. Some studies were conducted on homogenous samples limiting the generalizability of their results to other populations. Many studies were too short for determining the long-term effects of the web-based intervention. Celio Doyle et al.²³ demonstrated a statistically significant reduction in BMI z-scores post intervention that was not sustained at the four-months follow-up visit. White et al. and Williamson et al.²⁸⁻³¹ also showed a decrease in BMI at 6-months that was not sustained at 24-months follow-up.

Many of the included studies did not address cultural aspects of the participants. Cultural aspects, such as ethnicity, religious beliefs and practices, location and type of neighborhood are known to have a

considerable impact on healthy lifestyles choices of children and their families, and specifically on the obesity rate in a given population.^{25,30,31} According to Chen et al.²⁵ who conducted a study that provided individually tailored web-based behavior program for Chinese American adolescents, culturally appropriate programs may have more success at promoting healthy lifestyles and decreasing obesity.

A low adherence rate was another concern in many studies. Many of the researchers provided email reminders, telephone calls, and monetary incentives to increase log-on rates. In Baranowski et al.,²¹ all these methods were implemented yet log-in rates only improved for a short period of time. Jones et al.,²⁴ however, identified no correlation between adherence and outcome. Most of the participants used this 16-week online program for less than eight weeks, yet results indicated statistically significant reductions in BMI and BMI z-scores. Perhaps adolescents need a more structured program in conjunction with an online format in order to maintain momentum.

None of the studies included in the systematic review evaluated the effects of web-based interventions alone. The intervention had other components such as face-to-face counseling sessions, parental involvement, and phone and/or email communication, making it difficult to discern if the effects seen were the result of the web-based programs or some other component of the intervention.

Conclusions

The findings of this review suggest that web-based interventions as part of a complex multi-component weight reduction intervention program could have a positive impact in reducing BMI, BMI z-score, weight, and/or waist circumference. The studies included in this review suggest that other components, such as parental involvement, face-to-face mentoring, and feedback and reminders, when coupled with web-based weight management interventions, may improve patient outcomes. In addition, several studies highlighted the importance of culturally-sensitive interventions that are tailored to a specific cultural group in achieving desired outcomes. However, the long-term effects of web-based interventions have not been established.

Implications for practice

The evidence suggests that using web-based technology, as part of a complex multi-component weight reduction intervention program for the implementation of weight reduction initiatives in school-age children, is promising (Level 2, JBI Levels of Evidence). Additional components such as parental involvement, face-to-face mentoring, individualized feedback, and adherence reminders should be included alongside the web-based intervention to enhance positive outcomes (Level 2, JBI Levels of Evidence). The active intervention should occur over extended time periods to increase the potential for reducing childhood obesity.

Implications for research

Many of the interventions included in this review contained other components such as dietary, physical exercise, parental involvement, and culturally specificity. These components may have influenced the meaningful changes seen in program adherence, BMI, waist circumferences, body fat, and behavior. Future studies should further evaluate the effects of web-based interventions on the reduction of childhood obesity as a single entity and not part of a multi-component intervention. Additional research should be done to determine the optimal length of web-based interventions in maintaining long-term outcomes.

Conflicts of Interest

No conflict of interests to declare.

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Appendix I: Search strategies***CINAHL search strategy**

#1	(MH "Child") OR "child"
#2	"children"
#3	(MH "Adolescence") OR "adolescence"
#4	"adolescent"
#5	(MH "Obesity") OR "obesity"
#6	(MH "Obesity, Morbid") OR "morbid obesity"
#7	"overweight"
#8	"weight"
#9	(MH "Body Weight") OR "body weight"
#10	((MH "Pediatrics+") OR "Pediatrics") OR Pediatric
#11	(#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10)
#12	"web based"
#13	"online"
#14	(MH "Internet") OR "internet"
#15	"blogging" OR (MH "Blogs") or blogs
#16	"social media"
#17	(MH "World Wide Web") OR "world wide web"
#18	(MH "Communications Media") OR "communications media"
#19	(MH "Multimedia") OR "multimedia"
#20	"instructional media"
#21	"telecommunications media"
#22	(MH "Social Networks") OR "social network**"
#23	"mobile application**"
#24	(MH "Electronic Mail") OR "email**"
#25	(MH "Technology") OR "technology"
#26	"online social network**"
#27	"computer mediated communication"
#28	"electronic communication"
#29	(MH "Telecommunications") OR "telecommunications"
#30	(MH "Electronic Mail") OR "electronic mail"
#31	#12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or # 25 or #26 or #27 or #28 or # 29 or # 30
#32	(MH "Body Mass Index") OR "body mass index"
#33	(MH "Waist Circumference") OR "waist circumference"
#34	reduce or reduced or reduction or decrease or decreased or decline or declined
#35	(MH "Waist-Hip Ratio") OR "waist hip ratio"
#36	BMI
#37	(MH "Weight Loss") OR "weight loss" OR (MH "Weight Control") OR " weight control"
#38	#32 or #33 or #34 or #35 or #36 or #37
#39	#11 and #31 and #38

PubMed search strategy

#1	("children") OR (child) OR (adolescence)) OR (pediatric)
#2	("web based") OR (online) OR (internet) OR (blogging) OR ("social media"[MeSH Terms] OR "social media"[All Fields] OR ("world wide web")) OR ("blogs") OR ("communication media") OR (multimedia) OR ("Instructional Media") OR (Telecommunications) OR ("social network"[All Fields] OR ("social networking") OR ("social networks") OR ("Mobile application") OR ("mobile applications") OR ("electronic mail"[MeSH Terms] OR "electronic mail"[All Fields] OR "email"[All Fields]) OR (technology) OR ("computer mediated communication") OR ("electronic communication")
#3	("body mass index"[MeSH] OR "body mass index"[All Fields] OR ("waist circumference"[MeSH Terms] OR "waist circumference"[All Fields] OR ("reduce") OR ("reduction") OR ("decreased") OR ("BMI") OR ("body weight"[MeSH Terms] OR "body weight"[All Fields] OR ("weight loss"[MeSH Terms] OR "weight loss"[All Fields] OR ("waist-hip ratio"[MeSH Terms] OR "waist hip ratio"[All Fields] OR ("decrease") OR ("decline") OR ("reduced")) OR ("weight") OR ("weight control")
#4	("obesity"[MeSH Terms] OR "obesity"[All Fields] OR "morbid obesity"[All Fields] OR ("overweight"[MeSH Terms] OR "overweight"[All Fields])
#5	#1 and #2 and #3 and #4

ERIC search strategy

#1	child* or adolesc* or pediatric*
#2	obesity or obese or overweight
#3	"web based" or online or internet or blogging or "social media" or "world wide web" or blogs or "communications media" or multimedia or "instructional media" or "telecommunications media" or telecommunications or "social network" or "social networking" or "social networks" or "mobile application" or "mobile applications" or email or "electronic mail" or technology or "computer mediated communication" or "electronic communication"
#4	"body mass index" or "waist circumference" or weight or reduc* or decrease or decreased or decline or declined or "waist hip ratio" or bmi or "body weight" or "weight control" or BMI
#5	#1 and #2 and #3 and #4

PsycINFO search strategy

#1	child*
#2	adolescen*
#3	DE "Pediatrics" *
#4	pediatric*
#5	#1 and #2 and #3 and #4
#6	DE "Obesity" OR obesity
#7	DE "Overweight"
#8	overweight
#9	#6 and #7 and #8 and #9
#10	"web based"
#11	online
#12	DE internet OR internet
#13	blogging
#14	"social media"
#15	"world wide web"
#16	blog*
#17	DE communications media OR "communications media"
#18	DE multimedia OR multimedia
#19	DE instructional media OR "instructional media"
#20	DE telecommunications media OR "telecommunications media"
#21	telecommunications
#22	DE online social networks OR "social network" OR "social networking" OR "social networks"
#23	"mobile application" OR "mobile applications"
#24	email OR "electronic mail"
#25	DE technology OR "technology"
#26	DE computer mediated communications OR "computer mediated communications"
#27	DE electronic communication OR "electronic communication"
#28	#10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27
#29	DE body mass index OR "body mass index"
#30	"waist circumference"
#31	weight
#32	reduc*
#33	decreas*
#34	declin*
#35	"waist hip ratio"
#36	BMI
#37	DE body weight OR "body weight"
#38	DE weight control OR "weight control"
#39	DE weight loss OR "weight loss"
#40	#29 or #30 or #31 or #32 or #33 or #34 or #35 or #36 or #37 or #38 or #39
#41	#5 and #9 and #28 and #40

EMBASE search strategy

#1	'children'/de OR children
#2	'child'/de OR child
#3	'adolescent'/de OR adolescent
#4	adolescence
#5	pediatric*
#6	'pediatrics'/de OR pediatrics
#7	#1 or #2 or #3 or #4 or #5 or #6
#8	'obesity'/de OR obesity
#9	'morbid obesity'/de OR 'morbid obesity'
#10	'overweight'/de OR overweight
#11	#8 or #9 or #10
#12	'web based'
#13	online
#14	'internet'/de OR internet
#15	'blogging'/de OR blogging
#16	'social media'/de OR 'social media'
#17	'world wide web'/de OR 'world wide web'
#18	blog*
#19	'communications media'/de OR 'communications media'
#20	'multimedia'/de OR multimedia
#21	'instructional media'
#22	'telecommunications'/de OR telecommunications
#23	'social network'/de OR 'social network'
#24	'social networks'
#25	'social networking'/de OR 'social networking'
#26	'mobile applications'
#27	'email'/de OR email OR 'e mail'/de OR 'e mail'
#28	'technology'/de OR technology
#29	'computer mediated communication'
#30	'electronic communication'
#31	#12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30
#32	'body mass index'/de OR 'body mass index' OR bmi
#33	'waist circumference'/de OR 'waist circumference'
#34	'weight'/de OR weight
#35	reduc*
#36	decrease*
#37	declin*
#38	'waist hip ratio'/de OR 'waist hip ratio'
#39	'weight control'/de OR 'weight control'
#40	'weight loss'/de OR 'weight loss'
#41	'weight reduction'/de OR 'weight reduction'
#42	#32 or #33 or #34 or #35 or #36 or #37 or #38 or #39 or #40 or #41
#43	#7 and #11 and #31 and #42 and [embase]/lim and [1991-2013]/py and [english]/lim and ([child]/lim OR [adolescent]/lim)

Health Source: Nursing/Academic Edition search strategy

#1	child* or adolesc* or pediatric*
#2	obesity or obese or overweight
#3	"web based" or online or internet or blogging or "social media" or "world wide web" or blogs or "communications media" or multimedia or "instructional media" or "telecommunications media" or telecommunications or "social network" or "social networking" or "social networks" or "mobile application" or "mobile applications" or email or "electronic mail" or technology or "computer mediated communication" or "electronic communication"
#4	"body mass index" or "waist circumference" or weight or reduc* or decrease or decreased or decline or declined or "waist hip ratio" or bmi or "body weight" or "weight control" or BMI
#5	#1 and #2 and #3 and #4

Academic Search Premier search strategy

#1	child* or adolesc* or pediatric*
#2	obesity or obese or overweight
#3	"web based" or online or internet or blogging or "social media" or "world wide web" or blogs or "communications media" or multimedia or "instructional media" or "telecommunications media" or telecommunications or "social network" or "social networking" or "social networks" or "mobile application" or "mobile applications" or email or "electronic mail" or technology or "computer mediated communication" or "electronic communication"
#4	"body mass index" or "waist circumference" or weight or reduc* or decrease or decreased or decline or declined or "waist hip ratio" or bmi or "body weight" or "weight control" or BMI
#5	#1 and #2 and #3 and #4
#6	"randomized controlled trial" or "randomized controlled clinical trial" or "randomised controlled trial" or "randomised controlled clinical trial" or rct
#7	#5 and #6 [Limiters - Published Date from: 19910101-20131231]

New York Academy of Medicine search strategy

#1	(child* or adolesc* or pediatric*)
#2	(obes* or overweight) AND ("web based" or online or internet or blogging or "social media" or "world wide web" or blogs or "communications media" or multimedia or "instructional media" or "telecommunications media" or telecommunications or "social network" or "social networking" or "social networks" or "mobile application" or "mobile applications" or email or "electronic mail" or technology or "computer mediated communication" or "electronic communication")
#3	("body mass index" or "waist circumference" or weight or reduc* or decrease or decreased or decline or declined or "waist hip ratio" or bmi or "body weight" or "weight control" or BMI)
#4	#1 and #2 and #3

TRIP Database search strategy**

#1	(child or adolescent)
#2	(obese or overweight)
#3	("web based" or online or "social media" or internet or blog or "social network")
#4	("body mass index" or "waist circumference" or bmi or weight or "waist hip ratio")
#5	#1 and #2 and #3 and #4

SCIRUS search strategy**

#1	(child or adolescent)
#2	(obese or overweight)
#3	("web based" or online or "social media" or internet or blog or "social network")
#4	("body mass index" or "waist circumference" or bmi or weight or "waist hip ratio") and "randomized controlled trial" ("childhood obesity")
#5	#1 and #2 and #3 and #4

Google Scholar search strategy**

#1	(child or adolescent) and (obese or overweight) and ("web based" or online or "social media" or internet or blog or "social network")
----	---

ProQuest Dissertations and Theses search strategy

# 1	all (child* ORadolesc* OR pediatric*)
#2	all (obesity OR obese OR overweight)
#3	all ("web based" OR online OR internet OR blogging OR "social media" OR "world wide web" OR blogs OR "communications media" OR multimedia OR "instructional media" OR "telecommunications media" OR telecommunications OR "social network" OR "social networking" OR "social networks" OR "mobile application" OR "mobile applications" OR email OR "electronic mail" OR technology OR "computer mediated communication" OR "electronic communication")
#4	all("body mass index" OR "waist circumference" OR weight OR reduc* OR decrease OR decreased OR decline OR declined OR "waist hip ratio" OR bmi OR "body weight" OR "weight control" OR BMI)
#5	#1 and #2 and #3 and #4

Virginia Henderson International Nursing Library search strategy

#1	(child* ORadolesc* OR pediatric*)
#2	AND (obesity OR obese OR overweight)
#3	AND ("web based" OR online OR internet OR blogging OR "social media" OR "world wide web" OR blogs OR "communications media" OR multimedia OR "instructional media" OR "telecommunications media" OR telecommunications OR "social network" OR "social networking" OR "social networks" OR "mobile application" OR "mobile applications" OR email OR "electronic mail" OR technology OR "computer mediated communication" OR "electronic communication")

MedNar search strategy**

#1	((("childhood obesity") AND (prevention) AND (technology) AND (reduction))
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World Health Organization's Institutional Repository of Information Sharing search strategy**

#1	((("childhood obesity") AND (prevention) AND (technology) AND (reduction))
----	--

*All searches limited to the English language and these publications dates: 1991 to August 2012.

**Searches abbreviated due to limitations in the number of keywords that can be entered into the search engine.

Appendix II: Joanna Briggs Institute critical appraisal instrument

JBI Critical Appraisal Checklist for Randomised Control / Pseudo-randomised Trial

Reviewer _____ Date _____

Author _____ Year _____ Record Number _____

	Yes	No	Unclear	Not Applicable
1. Was the assignment to treatment groups truly random?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Were participants blinded to treatment allocation?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Was allocation to treatment groups concealed from the allocator?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Were the outcomes of people who withdrew described and included in the analysis?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Were those assessing outcomes blind to the treatment allocation?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Were the control and treatment groups comparable at entry?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Were groups treated identically other than for the named interventions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Were outcomes measured in the same way for all groups?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Were outcomes measured in a reliable way?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Was appropriate statistical analysis used?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Overall appraisal: Include Exclude Seek further info.

Comments (Including reason for exclusion)

Appendix III: Joanna Briggs Institute data extraction instrument

**JBI Data Extraction Form for
Experimental / Observational Studies**

Reviewer Date

Author Year

Journal_..... Record Number

Study Method

RCT Quasi-RCT Longitudinal
 Retrospective Observational Other

Participants

Setting _____

Population _____

Sample size

Group A _____ Group B _____

Interventions

Intervention A _____

Intervention B _____

Authors Conclusions:

Reviewers Conclusions:

Study results**Dichotomous data**

Outcome	Intervention () number / total number	Intervention () number / total number

Continuous data

Outcome	Intervention () number / total number	Intervention () number / total number

Appendix IV: List of excluded studies

1. Abroms LC, Fagan P, Eisenberg ME, Lee HSH, Remba N, Sorensen G. The STRENGTH Ezine: An application of e-mail for health promotion in adolescent girls. *American Journal of Health Promotion*. 2004;19(1):28-32.
Reason for exclusion: Not an RCT
2. Ahn Y, Kim KW. Study on utilization status of Internet and needs assessment for developing nutrition education programs among elementary school children. *Nutrition Research and Practice*. 2007;1(4):341-8.
Reason for exclusion: Not an RCT
3. Bauer S, de Niet J, Timman R, Kordy H. Enhancement of care through self-monitoring and tailored feedback via text messaging and their use in the treatment of childhood overweight. *Patient Education and Counseling*. 2010;79(3):315-9.
Reason for exclusion: Not an RCT
4. Casazza K, Ciccazzo M. The method of delivery of nutrition and physical activity information may play a role in eliciting behavior changes in adolescents. *Eating Behaviors*. 2007;8(1):73-82.
Reason for exclusion: Not an RCT
5. Christison A, Khan HA. Examining for health: A community-based pediatric weight management program using active video gaming. *Clinical Pediatrics*. 2012;51(4):382-8.
Reason for exclusion: Intervention differs from the inclusion criteria
6. Frenn M, Malin S, Brown RL, Greer Y, Fox J, Greer J, et al. Changing the tide: An Internet/video exercise and low-fat diet intervention with middle-school students. *Applied Nursing Research*. 2005;18(1):13-21.
Reason for exclusion: Not an RCT
7. Goran MI, Reynolds K. Interactive multimedia for promoting physical activity (IMPACT) in children. *Obesity Research*. 2012;13(4):762-71.
Reason for exclusion: Intervention differs from the inclusion criteria
8. Haerens L, Deforche B, Vandelanotte C, Maes L, De Bourdeaudhuij I. Acceptability, feasibility and effectiveness of a computer-tailored physical activity intervention in adolescents. *Patient Education and Counseling*. 2007;66(3):303.
Reason for exclusion: Outcomes differ from the inclusion criteria
9. Haerens L, Maes L, Vereecken C, De Henauw S, Moreno L, De Bourdeaudhuij I. Effectiveness of a computer tailored physical activity intervention in adolescents compared to a generic advice. *Patient Education and Counseling*. 2009;77(1):38-41.
Reason for exclusion: Outcomes differ from the inclusion criteria
10. Haerens L, De Bourdeaudhuij I, Maes L, Cardon G, Deforche B. School-based randomized controlled trial of a physical activity intervention among adolescents. *Journal of Adolescent Health*. 2007;40(3):258-65.
Reason for exclusion: Outcomes differ from the inclusion criteria
11. Haerens L, Deforche B, Maes L, Stevens V, Cardon G, Bourdeaudhuij I. Body mass effects of a physical activity and healthy food intervention in middle schools. *Obesity*. 2012;14(5):847-54.
Reason for exclusion: Outcomes differ from the inclusion criteria

12. Hamel LM, Robbins LB, Wilbur JE. Computer and web-based interventions to increase preadolescent and adolescent physical activity: A systematic review. *Journal of advanced nursing*. 2011;67(2):251-68.
Reason for exclusion: Systematic Review. Included studies reviewed against inclusion criteria.
13. Kidd T, Johannes E, Simonson L, Medeiros D. KNACK online: An evidence-based web site developed to address adolescent obesity. *Journal of Nutrition Education and Behavior*. 2008;40(3):189-90.
Reason for exclusion: Not an RCT
14. Maes L, Cook TL, Ottovaere C, Matthijs C, Moreno LA, Kersting M, et al. Pilot evaluation of the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Food-O-Meter, a computer-tailored nutrition advice for adolescents: A study in six European cities. *Public Health Nutrition*. 2011;14(7):1292.
Reason for exclusion: Not an RCT
15. Maddison R, Foley L, Mhurchu CN, Jull A, Jiang Y, Prapavessis H, et al. Feasibility, design and conduct of a pragmatic randomized controlled trial to reduce overweight and obesity in children: The electronic games to aid motivation to exercise (eGAME) study. *BMC Public Health*. 2009;9(1):146.
Reason for exclusion: Intervention differs from the inclusion criteria
16. Marks JT, Campbell MK, Ward DS, Ribisl KM, Wildemuth BM, Symons MJ. A comparison of web and print media for physical activity promotion among adolescent girls. *Journal of Adolescent Health*. 2006;39(1):96-104.
Reason for exclusion: Outcomes differ from the inclusion criteria
17. Mauriello LM, Ciavatta MMH, Paiva AL, Sherman KJ, Castle PH, Johnson JL, et al. Results of a multi-media multiple behavior obesity prevention program for adolescents. *Preventive Medicine*. 2010;51(6):451-6.
Reason for exclusion: Outcomes differ from the inclusion criteria
18. Mauriello L, Sherman K, Driskell M, Prochaska J. Using interactive behavior change technology to intervene on physical activity and nutrition with adolescents. *Adolescent Medicine: State of the Art Reviews*. 2007;18(2):383-99.
Reason for exclusion: Not an RCT
19. Nguyen B, Shrewsbury V, O'Connor J, Steinbeck K, Hill A, Shah S, et al. Two-year outcomes of an adjunctive telephone coaching and electronic contact intervention for adolescent weight-loss maintenance: The Loozit randomized controlled trial. *International Journal of Obesity*. [Epub ahead of print] 2012. doi: 10.1038/ijo.2012.74.
Reason for exclusion: No control group. Study does not separate out the telephone from the text/email contact so you cannot determine the results of the intervention of interest to this review.
20. Palmer S, Graham J, Elliott E. Effects of a web-based health program on fifth grade children's physical activity knowledge, attitudes and behavior. *American Journal of Health Education*. 2005;46(2):86-93.
Reason for exclusion: Not an RCT
21. Plischke M, Marschollek M, Wolf K, Haux R, Tegtbur U. CyberMarathon -- Increasing physical activity using health-enabling technologies. *Studies in Health Technology and Informatics*. 2008;136:449-54.
Reason for exclusion: Not an RCT

22. Pretlow RA. Addiction to highly pleasurable food as a cause of the childhood obesity epidemic: A qualitative Internet study. *Eating disorders*. 2011;19(4):295-307.
Reason for exclusion: Not an RCT
23. Robbins LB, Gretebeck KA, Kazanis AS, Pender NJ. Girls on the move program to increase physical activity participation. *Nursing Research*. 2006;55(3):206-16.
Reason for exclusion: Outcomes differ from the inclusion criteria
24. Sacher P, Chadwick P, Kolotourou M, Radley D, Chipperfield A, Steventson A, et al. From clinical trial to large-scale community implementation: Evaluation of the MEND multicomponent, family-based, child weight management programme in overweight and obese 7-13 year-old children in the United Kingdom. *Obesity Review*. 2010;11(Supplement s1):427-8.
Reason for exclusion: Outcomes differ from the inclusion criteria
25. Schiel R, Beltschikow W, Radón S, Kramer G, Schmiedel R, Berndt RD, et al. Long-term treatment of obese children and adolescents using a telemedicine support programme. *Journal of Telemedicine and Telecare*. 2008;14(1):13-6.
Reason for exclusion: Not an RCT
26. Whittemore R, Jeon S, Grey M. An Internet obesity prevention program for adolescents. *The Journal of Adolescent Health*. Forthcoming 2012.
Reason for exclusion: Study has no control intervention
27. Winett RA, Roodman AA, Winett SG, Bajzek W, Rovniak LS, Whiteley JA. The effects of the Eat4Life Internet-based health behavior program on the nutrition and activity practices of high school girls. *Journal of Gender, Culture, and Health*. 1999;4(3):239-54.
Reason for exclusion: Not an RCT

Appendix V: Included studies

Baranowski et al., 2003 ²¹	
Methods	Randomized controlled trial
Participants	35 eight-year-old healthy overweight African American girls from a summer camp in Houston, Texas, USA, and their parents/caregivers
Intervention	A four-week summer camp program with camp activities to promote healthy eating and physical activity. After the summer camp, participants and their parents received an additional eight-week web-based intervention at home aimed at improving healthy eating habits and physical activity. The website included goal-setting activities. The adolescents received weekly emails or telephone reminders to participate. The parental website promoted desired parenting behaviors and allowed parents to set goals for lifestyle changes for their daughters.
Control	A four-week summer camp that included usual camp activities followed by access to a website with general health information.
Results	No differences in BMI or waist circumference between the two groups at the end of the 12-week program. In a secondary analysis, when the sample was restricted to girls with a baseline BMI greater than 22.1, there was a trend toward a lower BMI for the treatment group (BMI 28.6) compared to the control group (BMI 29.3) post intervention.
Authors' conclusions	At the end of the 12-week web-based intervention, overall, there were no differences in BMI. However, after adjusting for baseline BMI as a covariate in a secondary analysis, when the sample was restricted to girls with a greater BMI, there was a trend toward a lower BMI for the treatment group compared to the control group.
Reviewers' comments	Limitations of this study include the small sample size, low adherence rates, and baseline differences in the mean BMI between groups at baseline (Intervention group 21.1, control group 26.3, $p < 0.01$). The participants were only girls making it difficult to generalize results to other populations. Individualized feedback, reminders, and parental involvement could be beneficial components in weight loss interventions.

Celio, 2005 ²²	
Methods	Randomized controlled trial
Participants	63 ethnically diverse overweight or at risk for overweight (BMI \geq 85 th percentile) adolescent boys and girls, aged 12-18 years from San Diego, California, USA, and St. Louis, Missouri, USA.
Intervention	A 16-week web-based program using a cognitive-behavioral approach to provide weekly content on health education, guided behavior modification for weight control, and cognitive exercises for improving body image using a gender specific Internet interface. Participants recorded food intake, physical activity, and weekly weights in an online journal. Participants were expected to spend one to two hours per week, but no more than 30 minutes a day using the program. Weekly emails were sent to participant with individualized feedback. The website provided an online, moderated, asynchronous discussion group. Parents also received monthly newsletters to encourage the creation of a positive and constructive home environment for the adolescents to achieve their goals.
Control	Adolescents and parents received a colored handout with basic health information and physician follow-ups as needed.
Results	The intervention demonstrated a statistically significant reduction in BMI z-scores in the intervention group compared to the control group at the end of the 16-week intervention ($F[5,60] = 5.11, p=0.027$). Results at 4-months post intervention reported in Celio Doyle et al. ²³
Authors' conclusions	The case analysis showed statistically significant reduction in BMI z-score post intervention.
Reviewers' Comments	Limitations of the study include the small sample and the lack of long term follow-up. Individualized feedback and parental involvement could be beneficial components in weight loss interventions.
Celio Doyle et al., 2008 ²³	
Methods	Randomized controlled trial
Participants	Same population as Celio ²² expanded to include a total of 80 participants
Intervention	Same as in Celio ²²
Control	Same as in Celio ²²
Results	The intervention demonstrated a statistically significant reduction in BMI z-scores in the intervention group compared to the control group at the end of the 16-week intervention ($F[5,60] = 5.11, p=0.027$); however, this reduction was not sustained at the four-months post intervention follow-up visit ($F[5,60] = 1.14, p=0.289$) due to parallel improvements in both the intervention and control groups.
Authors' Conclusions	Internet-delivered intervention resulted in modest reduction in weight that continued four-months after treatment. Group differences on weight loss were not sustained at four-months follow-up because of parallel improvements between the groups.
Reviewers' Comments	Limitations to this study include the small sample size and the lack of long term follow-up. The intervention group displayed skills taught to adopt a healthy lifestyle, which may translate into long term results. Individualized feedback and parental involvement could be beneficial components in weight loss interventions.

Chen et al., 2011 ²⁵	
Methods	Randomized controlled trial
Participants	54 Chinese American adolescent girls and boys, age 12-15 years old, from San Francisco, California, USA
Intervention	A web-based program consisted of activities in eight weekly online sessions each lasting 15 minutes to enhance the self-efficacy of adolescents and facilitate their understanding and use of problem solving skills related to nutrition, physical activity, and coping. Participants completed an online diary to monitor diet and physical activity and received individually tailored feedback based on the behavioral stage of the adolescent. Adolescents also used an interactive dietary preparation software program ("The Wok") featuring common Chinese foods. Parents of the adolescents in the intervention group received three sessions, each lasting 15-minutes, aimed at creating a healthy family environment.
Control	The control group received general health information related to nutrition and healthy lifestyle choices via the web during eight weekly sessions lasting 15 minutes each.
Results	The results demonstrated that more adolescents in the intervention group than the control group had decreased their waist:hip ratio (effect size = -0.01, p=0.02) at eight-months follow-up. No reduction in BMI was noted in either group.
Authors' Conclusions	The intervention resulted in significant decrease in waist:hip ratio, but no reduction in BMI scores were noted.
Reviewers' Comments	Limitations of the study include convenience sampling, the small sample size, use of single ethnic population, use of self-report measures, and a short follow-up time. Culturally sensitive interventions may enhance outcomes.
Ezendam et al., 2012 ²⁰	
Methods	Randomized controlled trial
Participants	883 adolescent boys and girls, age 12-13 years old, from 20 schools in the Netherlands
Intervention	The intervention consisted of a web-based intervention consisting of eight modules addressing issues of weight management and energy balance-related behaviors. Education included increasing physical activity, reducing sedentary lifestyle, increasing intake of fruits, vegetables and whole wheat breads, and reducing sugar beverages. Individual feedback was provided on behavior and cognitive modification and barrier identification. Teachers allocated 15 minutes for each module over 10 weeks.
Control	A regular curriculum, which was not detailed by the authors.
Results	The results demonstrated an increase in both BMI and waist circumferences at the two-years follow-up. Regression analysis at the two-years follow-up showed no effects of the intervention on BMI ($\beta=0.14$, 95% confidence interval -0.17, 0.45) or waist circumference ($\beta=0.12$, 95% confidence interval -0.44, 1.64).
Authors' Conclusions	The intervention was not strong enough to demonstrate sustained weight loss effects at two-years follow-up.
Reviewers' Comments	Measurements for BMI and waist circumference were not collected at the conclusion of the intervention, so the immediate effects of the intervention are unknown. Limitations to this study include self-reported measures, attrition, short duration of intervention, and difference in groups at baseline.

Jago et al., 2006 ²⁷	
Methods	Randomized controlled trial
Participants	473 Boy Scouts, age 10 to 14 year-olds, from Houston, Texas, USA
Intervention	The "Fit for Life" physical activity program, a nine-week program that included skill building activities at troop meetings along with a web-based role modeling, goal setting and problem-solving program. Participants received a 20-minute physical activity session during the troop meeting and were encouraged to continue activities outside of the meeting. Participants also logged into the study website twice per week to complete animated role-modeling activities and set goals.
Control	A similar nine-week program that included a fruit and vegetable intervention in place of the physical activity intervention.
Results	The results demonstrated an increase in BMI and BMI percentile at the six-months follow-up.
Authors' Conclusions	The BMI and BMI percentiles for both the intervention and control groups were greater at the six-months follow-up compared to baseline.
Reviewers' Comments	Limitations to this study include a small sample of single gender participants that were predominantly Anglo-American and middle class. There were seasonal effects that showed improvement in outdoor physical activity in the spring cohort compared to the fall cohort.
Jones et al., 2008 ²⁴	
Methods	Randomized Controlled Trial
Participants	105 adolescent boys and girls, mean age 15.1 years old, at risk for obesity (BMI \geq 85 th percentile) from Boise, Idaho, USA, and Hayward, California, USA
Intervention	A 16-week web-based intervention that combined psycho-education and behavioral interventions including self-monitoring, goal setting, and awareness of appetite triggers. The online interactive program involved journals for a diet log, weight, physical activity, and personal thoughts and goals. There was also an asynchronous discussion group moderated by a research assistant. Weekly letters were sent out to reinforce participation and motivational messages were mailed as well. To increase adherence, parents were provided with handbooks. Due to low adherence in the first cohort, participants in cohort 2 were given the option of meeting face-to-face with a mentor. However, these participants only attended one mentoring session.
Control	A regular curriculum, which was not detailed by the authors.
Results	The results demonstrated a statistically significant decrease in BMI ($t_{87} = -2.7$, $p < 0.01$, effect size 0.6) and BMI z-score ($t_{87} = -3.1$, $p < 0.01$, effect size 0.8) from baseline to the follow-up in the intervention group compared to the control group. The intervention group experienced a greater reduction in overall BMI and BMI-z scores from baseline to follow-up.
Authors' Conclusions	The study supports an internet-facilitated intervention as yielding moderate weight loss and management in the short term.
Reviewers' Comments	Limitations to this study include the lack of correlation between adherence and outcome. It was noted that most participants used the online program less than eight-weeks, yet were able to reduce their weight and BMI. Face-to-face mentoring as offered but with limited utilization by participants. The interactive program encouraged a journal of the participant's diet, physical activity, personal thoughts, and goals.

Moore and O'Donohue, 2011 ²⁶	
Methods	Randomized controlled trial
Participants	30 at-risk or overweight children, aged six-12 years, and their caregivers from small rural towns in California and Nevada, USA
Intervention	A web-based psycho-education program consisting of five family-based interactive modules addressing behavior modification and self-monitoring, nutrition, physical activity, child management skills training, and relapse prevention. Families were also provided with monitoring logs, journals, recipes, and self-help resources.
Control	Usual care, which was not detailed by the study authors.
Results	The results demonstrated that BMI z-scores remained stable from baseline to post intervention for children in both groups.
Authors' Conclusions	This intervention demonstrated stability in health status over time. The study demonstrated the problems of attrition and adherence common in managing childhood obesity. Further research is needed to evaluate long-term outcomes.
Reviewers' Comments	Limitations to this study include a small sample size, high attrition rate, and a short follow-up period. Parental involvement could be a beneficial component in weight loss interventions.

White, 2003 ²⁸	
Methods	Randomized controlled trial
Participants	57 African American adolescent girls, age 11-15 years old, with at least one obese parent from Louisiana, USA
Intervention	An interactive web-based lifestyle behavior modification program for weight management or a control intervention. The web-based behavioral program utilized by both the adolescent and the parent consisted of 52 lesson plans to be completed over the first year of this two-year program. Lessons included nutritional education and a behavior modification program that targeted the lifestyle, physical activity, and eating habits, including recipes for food commonly eaten by African Americans. Participants also attended four face-to-face counseling sessions and were encouraged to adhere to the behavioral principles. Further counseling for behavior modification was accomplished by asynchronous e-mail communication. Along with providing e-mail access, the website contained a variety of interactive components for self-monitoring weight, diet, and physical activity.
Control	Health education during face-to-face sessions and links to non-interactive websites promoting a healthy lifestyle without prescribing behavior changes.
Notes	Dissertation reporting 6-month results of the intervention. See Williamson et al. ³⁰ for the 6-month results and Williamson et al. ³¹ for the 24-month results.

White et al., 2004 ²⁹	
Methods	Randomized controlled trial
Participants	Same population as in White ²⁸
Intervention	Same intervention as in White ²⁸
Control	Same control as in White ²⁸
Notes	Subsequent article of 6 month results reported in the White ²⁸ dissertation See Williamson et al. ³⁰ for the 6-month results and Williamson et al. ³¹ for the 24-month results.

Williamson et al., 2005 ³⁰	
Methods	Randomized controlled trial
Participants	Same population as in White ²⁸
Intervention	Same intervention as in White ²⁸
Control	Same control as in White ²⁸
Results	Re-analysis of the six-month results of the intervention detailed in White ²⁸ and White, et al. ²⁹ The results indicate that in the first six-months adolescents in the intervention group, when compared to the control group, had a statistically significant decrease in mean body fat ($p < 0.05$ [statistical test results not reported by authors]) and BMI ($p < 0.05$ [statistical test results not reported by authors]). Looking at BMI percentile, the intervention group approached a statistically significant difference at six-months ($t_{53} = 1.94$, $p = 0.057$).
Authors' Conclusions	At the six-months follow-up, the participant in the intervention group lost more body fat compared to the control group.
Reviewers' Comments	See Williamson et al. ³¹ for the 24-months follow-up results. Limitations of the study include the small sample size and the homogenous sample of African American girls. Individualized counseling and parental involvement could be a beneficial component in weight loss interventions.

Williamson et al., 2006 ³¹	
Methods	Randomized controlled trial
Participants	Same population as in White ²⁸
Intervention	Same intervention as in White ²⁸
Control	Same control as in White ²⁸
Results	24-month results of the intervention detailed in White, ²⁸ White et al., ²⁹ and Williamson et al. ³⁰ Weight loss was seen after the first six-months (as reported in Williamson, et al. ³⁰). Over the next 18-months of the study the participants gained weight. Statistically significant changes over time were observed in weight ($F[3,54] = 6.55$, $p < 0.001$), BMI percentile ($F[3,54] = 4.14$, $p < 0.02$), and BMI ($F[3,54] = 3.13$, $P < 0.04$).
Authors' Conclusions	During the first six-months adolescents in the intervention group demonstrated a decrease in body fat and BMI. However, long-term effects were not sustained at the 24-month assessment, and weight that was lost in the first six-months was regained.
Reviewers' Comments	Limitations of the study include the small sample size and the use of a homogenous sample of African American girls, which limits the generalizability of the results. Individualized counseling and parental involvement could be a beneficial component in weight loss interventions. Culturally sensitive interventions may enhance outcomes.